See R.A.E., B, vi, p. 103
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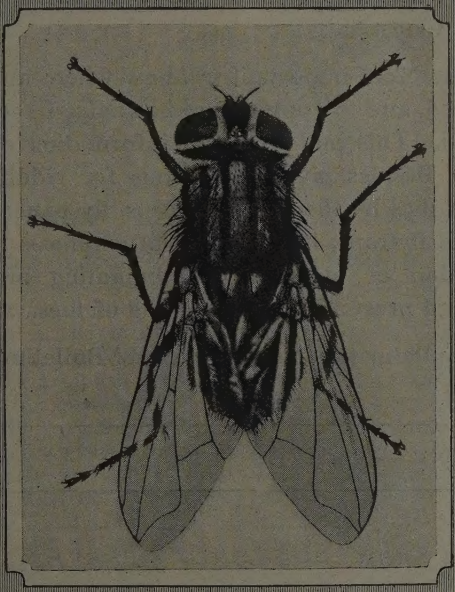
3 JUL. 1924
ENTOM.

U. S. DEPARTMENT OF AGRICULTURE
FARMERS' BULLETIN No. 1408

The HOUSE FLY AND HOW TO SUPPRESS IT



THE PRESENCE of flies is an indication of uncleanliness, insanitary conditions, and improper disposal of substances in which they breed. They are not only annoying; they are actually dangerous to health, because they may carry disease germs to exposed foods.

It is therefore important to know where and how they breed, and to apply such knowledge in combating them. This bulletin gives information on this subject. Besides giving directions for ridding the house of flies by the use of screens, fly papers, poisons, and flytraps, it lays especial emphasis on the explanation of methods of eliminating breeding places and preventing the breeding of flies.

This bulletin supersedes Farmers' Bulletin 851.

Washington, D. C. April, 1924

THE HOUSE FLY[1] AND HOW TO SUPPRESS IT.

By L. O. Howard, *Chief of the Bureau of Entomology*, and F. C. Bishopp, *Entomologist.*

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KINDS OF FLIES FOUND IN HOUSES.

SEVERAL species of flies are found commonly in houses. Some of them so closely resemble the true house fly that it requires very careful observation to distinguish them from it.

One of these is the biting stable fly[2] (fig. 1). It occurs frequently in houses and differs from the house fly in the important particular that its mouth parts are formed for piercing the skin. This fly is so often mistaken for the house fly that most people think that the house fly can bite.

Another frequent visitant of houses, particularly in the spring and fall, is the cluster fly.[3] It is somewhat larger than the house fly, and is distinguished by its covering of fine yellowish hairs. Occasionally this fly occurs in houses in such numbers as to cause great annoyance. It gets its name of "cluster fly" from its habit of collecting in compact groups or clusters in protected corners during cold periods.

Several species of metallic greenish or bluish flies also are found occasionally in houses. These include a blue-bottle fly,[4] the black blowflies,[5] and the green-bottle (fig. 2) flies.[6] They breed in decaying animal matter.

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[1] *Musca domestica* L.
[2] *Stomoxys calcitrans* L.
[3] *Pollenia rudis* Fab.
[4] *Calliphora erythrocephala* Meig.
[5] *Phormia regina* Meig. and *P. terræ-novæ* Desv.
[6] *Lucilia cæsar* L., *L. sericata* Meig., and other species of the genus.

There is still another species, smaller than any of those so far mentioned, which is sometimes called the "lesser house fly."[7] This insect is distinguished from the ordinary house fly by its paler and more pointed body. The male, which is commoner than the female, has large pale patches at the base of the abdomen, which are translucent when the fly is seen on the window pane. These little

FIG. 1.—The stable fly. Much enlarged.

FIG. 2.—One of the green-bottle flies (*Lucilia caesar*). Much enlarged.

flies are not the young of the larger flies. Flies do not grow after the wings have once expanded and dried.

In late summer and autumn many specimens of a small fruit fly, known as the "vinegar fly,"[8] make their appearance, attracted by the odor of overripe fruit.

All of these species, however, are greatly dwarfed in numbers by the common house fly. In 1900 the senior author made collections of the flies in dining rooms in different parts of the country, and found that the true house fly made up 98.8 per cent of the whole number captured. The remainder comprised various species, including those mentioned above.

FIG. 3.—The true house fly. Enlarged.

WHERE THE TRUE HOUSE FLY LAYS ITS EGGS.

The true house fly (fig. 3), which is found in nearly all parts of the world, is a medium-sized fly with four black stripes on the back and a sharp elbow in one of the veins of the wings. The house fly can not bite, its mouth parts being spread out at the tip for sucking up liquid substances.

The eggs (figs. 4, 5) are laid upon horse manure. This substance seems to be its favorite larval food. It will breed also in human excrement, and because of this habit it is very dangerous to the health of human beings, carrying as it does the germs of intestinal diseases, such as typhoid fever and cholera, from the

[7] *Fannia canicularis* L. [8] *Drosophila ampelophila* Loew.

excreta to food supplies. It has also been found to breed freely in hog manure, in considerable numbers in chicken dung, and to

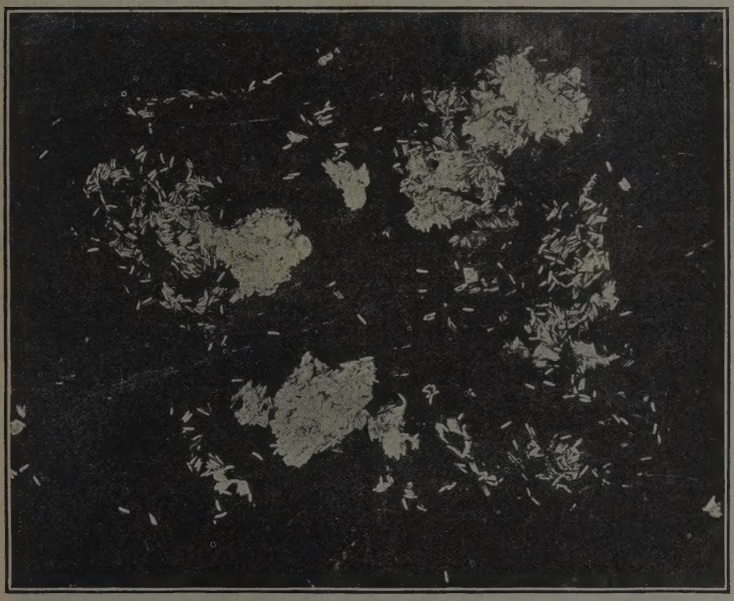

FIG. 4.—Eggs of the house fly. About natural size. (Newstead.)

some extent in cow manure. Indeed, it will lay its eggs on a great variety of decaying vegetable and animal materials, but of the flies that infest dwelling houses, both in cities and on farms, a vast proportion come from horse manure.

FIG. 5.—Eggs of the house fly. Highly magnified. (Newstead.)

It often happens, however, that this fly is very abundant in localities where little or no horse manure is found, and in such cases it breeds in other manure, such as chicken manure in backyard poultry lots, or in slops or fermenting vegetable material, such as spent hops, moist bran, ensilage, or rotting potatoes. Accumulations of organic material on the dumping grounds of towns and cities often produce flies in great numbers.

The house fly begins laying eggs in from 2½ to 20 days after emerging, the time interval depending to a large extent upon temperature, humidity, and character and abundance of food. The number of eggs laid by an individual fly at one time ranges from 120 to 159

and a single female will usually lay two and sometimes four such batches. Dunn has recently reported that in Panama a fly may deposit as many as 2,367 eggs in 21 batches, and sometimes an interval of only 36 hours may occur between the deposition of large batches of eggs. The enormous numbers in which the insects occur are thus plainly accounted for, especially when the abundance and universal occurrence of appropriate larval food is considered. The eggs are deposited below the surface in the cracks and interstices of the manure, several females usually depositing in one spot, so that the eggs commonly are found in large clusters (fig. 4) in selected places near the top of the pile, where a high degree of heat is maintained by the fermentation below. The second batch of eggs is laid from 8 to 10 days after the first. The eggs usually hatch in less than

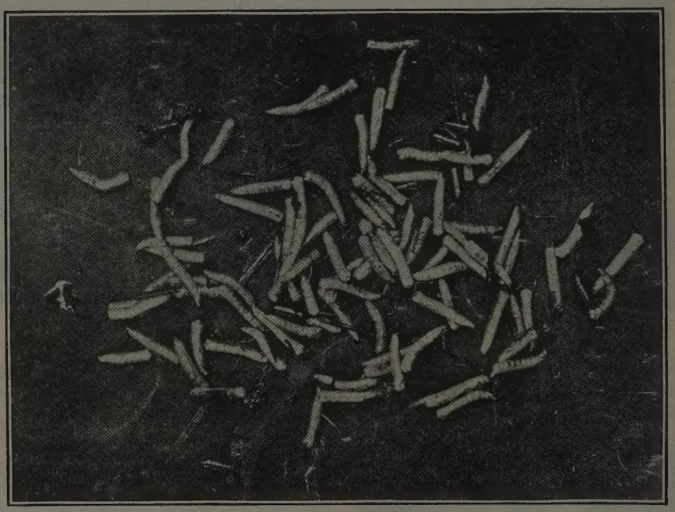

FIG. 6.—Larvæ, or maggots, of the house fly. About natural size. (Newstead.)

24 hours. Under the most favorable conditions of temperature and moisture the egg state may last hardly more than 8 hours. The maggots which issue from the eggs are very small and transparent. They grow rapidly, completing the growth of the larva stage in three days under the most favorable conditions, although this stage usually lasts from 4 to 7 days. The larval period may be prolonged greatly by low temperature or by dryness or scarcity of the larval food. As the larvæ (fig. 6) attain full size they gradually assume a creamy white color. A few hours before pupation they become very restless and migrate from their feeding ground in search of a favorable place in which to pass the pupa stage. They will often congregate at the edges of manure piles near the ground or burrow into the soil beneath, or they may crawl considerable distances away from the pile to pupate in the ground or in loose material under the edges of stones, boards, etc.

The pupæ (fig 7), or "sleepers," are more or less barrel shaped and dark brown in color. In midsummer this stage usually lasts from 3 to 6 days. The pupa stage is easily affected by temperature changes and may be prolonged during hibernation for as long as 4 or 5 months. Numerous rearing experiments in various parts of the country have shown that the shortest time between the deposition of eggs and the emergence of the adult fly is 8 days, and 10 and 12 day records were very common.

The adult fly, upon emerging from the puparium, works its way upward through the soil or manure and upon reaching the air it crawls about while its wings expand and the body hardens and assumes its normal coloration. In from 2½ to 20 days, as previously stated, the female is ready to deposit eggs. As in the case of other

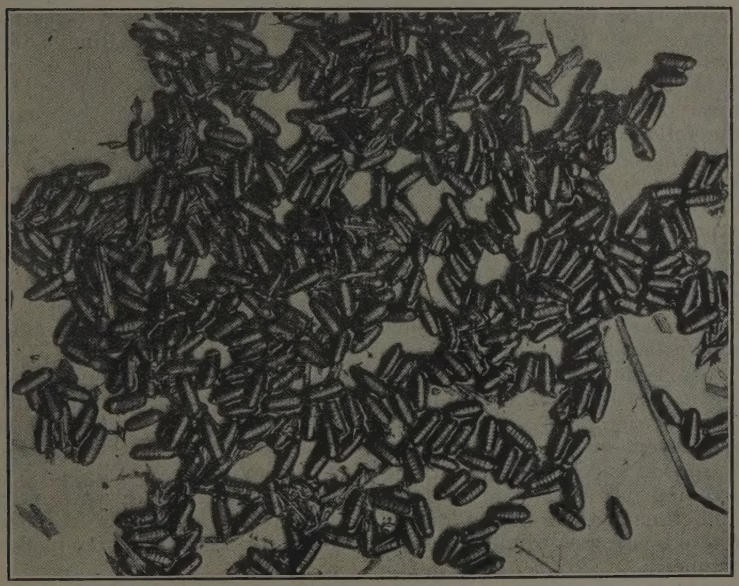

FIG. 7.—Pupæ of the house fly. About natural size. (Newstead.)

periods of its life history, so the preoviposition period is prolonged considerably by the lower temperatures of spring and fall. In midsummer, with a developmental period of from 8 to 10 days from egg to adult, and a preoviposition period of from 3 to 4 days, a new generation would be started every 11 to 14 days. Thus the climate of the District of Columbia allows abundance of time for the development of from 10 to 12 generations every season.

Flies usually remain near their breeding places if they have plenty of food, but experiments recently made at Dallas, Tex., show that they may migrate considerable distances; in fact, house flies, so marked that the particular individuals could be identified, have been recaptured in traps as far as 13 miles from the place where they were liberated.

HOW THE HOUSE FLY PASSES THE WINTER.

The prevailing opinion that the house fly lives through the winter as an adult, hiding in cracks and crevices of buildings, etc., appears to be erroneous. Under outdoor conditions house flies are killed during the first really cold nights, that is, when the temperature falls to about 15° or 10° F. In rooms and similar places protected from winds and partially heated during the winter flies have been kept alive in cages for long periods; but they never lived through the entire winter. In longevity experiments one record of 70 days and another of 91 days was obtained. No uncaged house flies were found during three seasons' observations in unheated and only partially heated attics, stables, unused rooms, etc., where favorable temperature conditions prevailed. The common occurrence in such places of the cluster fly and a few other species, which may be easily mistaken for the house fly, is responsible for the prevailing belief as to the way the house fly overwinters. There is therefore no reliable evidence whatever that adult house flies emerging during October and November pass the winter and are able to deposit their eggs the following spring, although they may continue active in heated buildings until nearly the end of January. On the other hand, there is evidence that house flies pass the winter as larvæ and pupæ, and that they sometimes breed continuously throughout the winter. In experiments at both Dallas, Tex., and Bethesda, Md., house flies have been found emerging during April from heavily infested manure heaps which had been set out and covered with cages during the preceding autumn. In the Southern States, during warm periods in midwinter, house flies may emerge and become somewhat troublesome; they frequently lay eggs on warm days.

The second way in which the house fly may pass the winter is by continuous breeding. House flies congregate in heated rooms with the approach of the winter season. If no food or breeding materials are present they eventually die. However, where they have access to both food and suitable substances for egg laying they will continue breeding just as they do outdoors during the summer. Even in very cold climates there are undoubtedly many places, especially in cities, where house flies would have opportunity to pass the winter in this manner.

CARRIAGE OF DISEASE BY THE HOUSE FLY.

The body of the house fly is covered thickly with hairs and bristles of varying lengths, and this is especially true of the legs. Thus, when it crawls over infected material it readily becomes loaded with germs, and subsequent visits to human foods result in their contamination. Even more dangerous than the transference of germs on the legs and body of the fly is the fact that bacteria are found in greater numbers and live longer in its alimentary canal. These germs are voided, not only in the excrement of the fly, but also in small droplets of regurgitated matter which have been called "vomit spots." When we realize that flies frequent and feed upon the most filthy substances (it may be the excreta of typhoid or dysentery patients or the discharges of one suffering from tuberculosis), and that subsequently they may contaminate human foods with their feet or excreta

or vomit spots, the necessity and importance of house-fly control is clear.

In army camps, in mining camps, and in great public works, where large numbers of men are brought together for a longer or shorter time, there is seldom the proper care of excreta, and the carriage of typhoid germs from the latrines and privies to food by flies is common and often results in epidemics of typhoid fever.

And such carriage of typhoid is by no means confined to great temporary camps. In farmhouses in small communities, and even in badly cared for portions of large cities, typhoid germs are carried from excrement to food by flies, and the proper supervision and treatment of the breeding places of the house fly become most important elements in the prevention of typhoid.

In the same way other intestinal germ diseases, such as Asiatic cholera, dysentery, enteritis (inflammation of the intestine), and infantile diarrhea, are all so carried. There is strong circumstantial evidence also that tuberculosis, anthrax, yaws, ophthalmia, smallpox, tropical sore, and the eggs of parasitic worms may be and are carried in this way. In the case of over 30 different disease organisms and parasitic worms, actual laboratory proof exists, and where lacking is replaced by circumstantial evidence amounting almost to certainty.

EXCLUDING AND CAPTURING FLIES.

The principal effort to control this dangerous insect must be made at the source of supply—its breeding places. Absolute cleanliness and the removal or destruction of anything in which flies may breed are essential; and this is something that can be done even in cities. Perhaps it can be done more easily in the cities than in villages, on account of their greater police power and the lesser insistence on the rights of the individual. Once people are educated to the danger and learn to find the breeding places, the rest will be easy.

In spite of what has just been said, it is often necessary to catch or otherwise destroy adult flies, or to protect food materials from contamination and persons from annoyance or danger; hence the value of fly papers and poisons, flytraps, and screens.

THE USE OF SCREENS.

A careful screening of windows and doors during the summer months, with the supplementary use of sticky fly papers, is a protective measure against house flies known to everyone. As regards screening, it is only necessary here to emphasize the importance of keeping food supplies screened or otherwise covered so that flies can gain no access to them. This applies not only to homes, but also to stores, restaurants, milk shops, and the like. Screening, of course, will have no effect in decreasing the number of flies, but at least it has the virtue of lessening the danger of contamination of food. Screens should be well made and durable. In dry climates black or painted screen wire will last fairly well and give satisfaction; in moderately moist climates, however, it will rust, and it is better to use the best grades of galvanized wire; and in humid regions, especially if near the seacoast, bronze wire or monel metal wire is un-

doubtedly the least expensive in the long run. A screen having a mesh of 14 strands to the inch, the kind commonly sold, is satisfactory for excluding flies, if unbroken, but a finer mesh is necessary to exclude the smaller mosquitoes.

FLY PAPERS AND POISONS.

The use of sticky fly papers to destroy flies that have gained access to houses is well known. Fly-poison preparations also are common. Many of the commercial fly poisons contain arsenic, and their use in the household is attended with considerable danger, especially to children. This danger is less with the use of a weak solution of formalin. A very effective fly poison is made by adding 3 teaspoonfuls of the commercial formalin to a pint of milk or water sweetened with a little brown sugar. A convenient way of exposing this poison is by partly filling an ordinary drinking glass with the solution. A saucer or plate is then lined with white blotting paper cut the size of the dish and placed bottom up over the glass. The whole is then quickly inverted and a small match stick placed under the edge of the glass. As the solution evaporates from the paper more flows out from the glass and thus the supply is automatically renewed.

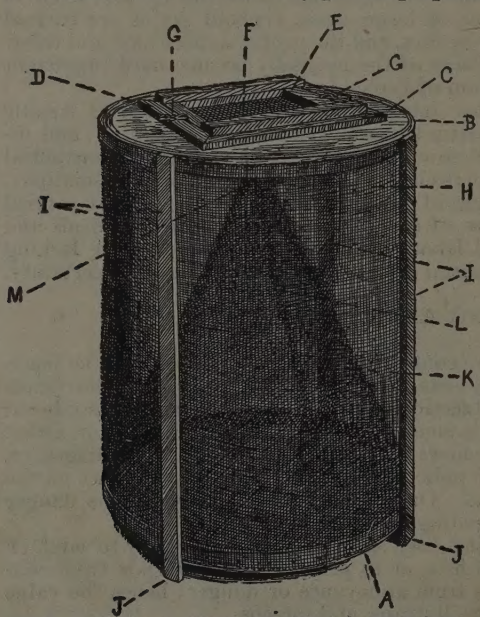

FIG. 8.—Conical hoop flytrap, side view. *A*, Hoops forming frame at bottom. *B*, Hoops forming frame at top. *C*, Top of trap made of barrel head. *D*, Strips around door. *E*, Door frame. *F*, Screen on door. *G*, Buttons holding door. *H*, Screen on outside of trap. *I*, Strips on side of trap between hoops. *J*, Tips of these strips projecting to form legs. *K*, Cone. *L*, United edges of screen forming cone. *M*, Aperture at apex of cone. (Bishopp.)

FLYTRAPS.

Flytraps may be used to advantage in decreasing the number of flies. Their use has been advocated not only because of the immediate results, but because of the chances that the flies may be caught before they lay eggs, and the number of future generations will be reduced greatly.

Many types of flytraps are on the market. As a rule the larger ones are the more effective. Anyone with a few tools can construct flytraps for a small part of the price of the ready-made ones. A trap (fig. 8) which is very effective in catching flies and is easily made, durable, and cheap, may be made of four barrel hoops, four laths, a few strips of boxing, and 8½ lineal feet of screening, 24 inches wide. (For greater details see Farmers' Bulletin 734.)

The effectiveness of the traps will depend on the selection of baits. A good bait for catching house flies is 1 part of blackstrap molasses to 3 parts of water, after the mixture has been allowed to ferment for a day or two. Overripe or fermenting bananas crushed and placed in the bait pans give good results, especially with milk added to them. A mixture of equal parts brown sugar and curd of sour milk, thoroughly moistened, gives good results after it has been allowed to stand for three or four days.

PREVENTING THE BREEDING OF FLIES.

As previously stated, fly papers, poisons, and traps are at best only temporary expedients. The most logical method of abating the fly nuisance is the elimination or treatment of all breeding places. It would appear from what is known of the life history and habits of the common house fly that it is perfectly feasible for cities and towns to reduce the numbers of this annoying and dangerous insect so greatly as to render it of comparatively slight account. On farms also, in dairies, and under rural conditions generally, much can and should be done to control the fly, which here, as elsewhere, constitutes a very serious menace to health.

CONSTRUCTION AND CARE OF STABLES.

In formulating rules for the construction and care of stables and the disposal of manure the following points must be taken into consideration. In the first place, the ground of soil-floor stables may offer a suitable place for the development of fly larvæ. The larvæ will migrate from the manure to the soil and continue their growth in the moist ground. This takes place to some extent even when the manure is removed from the stables every day. Even wooden floors are not entirely satisfactory unless they are perfectly water-tight, since larvæ will crawl through the cracks and continue their development in the moist ground below. Water-tight floors of concrete or masonry, therefore, are desirable. Flies have been found to breed in surprising numbers in small accumulations of material in the corners of feed troughs and mangers, and it is important that such places be kept clean.

FLY-TIGHT MANURE PITS.

The Bureau of Entomology for a number of years has advised that manure from horse stables be kept in fly-tight pits or bins. Such pits can be built in or attached to the stable so that manure can be easily thrown in at the time of cleaning and so constructed that the manure can be readily removed. It is desirable that the manure be placed in these fly-proof receptacles as soon as possible

after it is voided. The essential point is that flies be prevented from reaching the manure, and for this reason the pit or bin must be tightly constructed, preferably of concrete, and the lid kept closed except when the manure is being thrown in or removed. The difficulty has been that manure often becomes infested before it is put into the container, and flies frequently breed out before it is emptied and often escape through the cracks. To obviate these difficulties a manure box or pit with a modified tent trap or cone trap attached is desirable.

In order to retain the fertilizing value of manure to the greatest extent it is advisable that air be excluded from it as much as possible and that it be protected from the leaching action of rains. This being the case, there is really no necessity for covering a large portion of the top of the box with a trap, but merely to have holes large enough to attract flies to the light, and to cover these holes with ordinary conical traps, with the legs cut off, so that the bottoms of the traps will fit closely to the box. The same arrangement can be made where manure is kept in a pit. If manure boxes or pits are kept fly tight they are satisfactory under farm or dairy conditions for the storage of manure during the busy season when it can not be hauled out daily.

FREQUENCY WITH WHICH MANURE SHOULD BE REMOVED IN CITIES AND TOWNS.

In deciding the question as to how often manure should be removed in cities and towns, it should be borne in mind that when the larvæ have finished feeding they will often leave the manure and pupate in the ground below or crawl some distance away to pupate in débris under boards or stones and the like. Hence the manure should be removed before the larvæ reach the migratory stage; that is to say, removal is necessary every three days, and certainly not less frequently than twice a week during the summer months. A series of orders issued in 1906 by the health department of the District of Columbia, on the authority of the Commissioners of the District, covers most of these points, and these orders, which may well serve as a model to other communities desiring to undertake similar measures, may be briefly condensed as follows:

HEALTH OFFICE REGULATIONS FOR CONTROL OF HOUSE FLIES IN CITIES.

All stalls in which animals are kept shall have the surface of the ground covered with a water-tight floor. Every person occupying a building where domestic animals are kept shall maintain in connection therewith a bin or pit for the reception of manure and, pending the removal from the premises of the manure from the animal or animals, shall place such manure in said bin or pit. This bin shall be so constructed as to exclude rain water and shall in all other respects be water-tight, except as it may be connected with the public sewer. It shall be provided with a suitable cover and constructed so as to prevent the ingress and egress of flies. No person owning a stable shall keep any manure or permit any manure to be kept in or upon any portion of the premises other than the bin or pit described, nor shall he allow any such bin or pit to be overfilled or needlessly uncovered. Horse manure may be kept tightly rammed into well-covered barrels for the purpose of removal in such barrels. Every person keeping manure in the more densely populated parts of the District shall cause all such manure to be removed from the premises at least twice every week between June 1 and October 31, and at least once every week between November 1 and May 31 of the following year. No person

shall remove or transport any manure over any public highway in any of the more densely populated parts of the District except in a tight vehicle, which, if not inclosed, must be effectually covered with canvas, so as to prevent the manure from being dropped. No person shall deposit manure removed from the bins or pits within any of the more densely populated parts of the District without a permit from the health officer. Any person violating any of the provisions shall, upon conviction thereof, be punished by a fine of not more than $40 for each offense.

Not only must horse stables be cared for, but chicken yards, piggeries, and garbage receptacles as well. In cities, with better methods of disposal of garbage and with the lessening of the number of horses and horse stables consequent upon electric street railways, bicycles, and automobiles, the time may come, and before very long, when window screens may be discarded.

DISPOSAL OF MANURE IN RURAL AND SUBURBAN DISTRICTS.

The control of flies in rural and suburban districts offers a much more difficult problem. Here it is often out of the question to remove all manure from the premises twice a week, and the problem is to find some method of disposal or storage which will conserve the fertilizing value of the manure and at the same time prevent all flies from breeding, or destroy such as do breed there.

With this idea in mind, it has been recommended that stable manure be collected every morning and hauled out at once and spread rather thinly on the fields. This procedure is advisable from the point of view of getting the maximum fertilizing value from the manure. Immediate spreading on the fields is said largely to prevent the loss of plant food which occurs when manure is allowed to stand in heaps for a long time. This method will be effective in preventing the breeding of flies only if the manure is hauled out promptly every morning and spread thinly so that it will dry, since it is unfavorable for fly development in desiccated condition. The proper scattering of the manure on the fields is best and most easily and quickly accomplished by the use of a manure spreader, and many dairies, and even farms, are practicing the daily distribution of manure in this way. Removal every three or four days will not be sufficient. Observations have shown that if manure becomes flyblown and the maggots attain a fairly good size before the manure is scattered on the fields, they can continue their development and will pupate in the ground.

CHEMICAL TREATMENT OF MANURE TO DESTROY FLY MAGGOTS.

During the summer months, when fly breeding is going on most actively, the farmer is also busy and often can not spare the time to remove manure regularly. The general practice, therefore, has been to keep the manure in heaps located, as a rule, very near the stables. How can fly breeding be prevented in such accumulations? As a result of recent investigations, it is now possible to point out two methods which are practical and effective.

The first is the treatment of the manure pile with chemical substances which will kill the eggs and maggots of the house fly. The Bureau of Entomology, in cooperation with the Bureau of Chemistry and the Bureau of Plant Industry, has conducted a series of experiments in which a large number of chemicals were applied to infested

manure and observations made not only on their efficiency in killing the maggots but also as to their effect on the chemical composition and bacterial flora of the manure. The object was to find some cheap chemical which would be effective in destroying the fly larvæ and at the same time would not reduce the fertilizing value of the manure.

TREATMENT WITH HELLEBORE.

Of the numerous substances tried, the one which seems best to fulfill these conditions is powdered hellebore.[9] For the treatment of manure a water extract of the hellebore is prepared by adding ½ pound of the powder to every 10 gallons of water, and after stirring it is allowed to stand 24 hours. The mixture thus prepared is sprinkled over the manure at the rate of 10 gallons to every 8 bushels (10 cubic feet) of manure. From the result of 12 experiments with manure piles treated under natural conditions it appears that such treatment results in the destruction of from 88 to 99 per cent of the fly larvæ.

Studies of treated manure indicated that its composition and rotting were not interfered with. Furthermore, several field tests showed that there was no apparent injury to growing crops when fertilized with treated manure.

Since the solution is somewhat poisonous it should not be left exposed where it might be drunk by livestock. It is quite safe to say that chickens will not be injured by pecking at hellebore-treated manure. This has been tested carefully. Hellebore can be obtained both in ground and powdered form, but the powder gives the best results in the destruction of fly larvæ.

TREATMENT WITH POWDERED BORAX.

Another chemical found to be even more effective as a larvicide is powdered borax. This substance is available in commercial form in all parts of the country. It has the advantage of being comparatively nonpoisonous and noninflammable and is easily transported and handled. The minimum amount necessary to kill fly larvæ was found to be 0.62 pound per 8 bushels of manure, or about 1 pound per 16 cubic feet. Best results were obtained when the borax was applied in solution, or when water was sprinkled on after the borax had been scattered evenly over the pile. Borax is not only effective in killing the larvæ, but when it comes in contact with the eggs it prevents them from hatching. When applied at the rate of 1 pound to 16 cubic feet it was found to kill about 90 per cent of the larvæ, heavier applications killing from 98 to 99 per cent.

Borax has no injurious effect on the chemical composition or rotting of the manure. However, when added in large quantities with manure to the soil it will cause considerable injury to growing plants. A number of experiments have been conducted to determine the effect on crops of the use of manure treated with borax as herein recommended. When applied at the rate of 15 tons per acre it appears that no injury as a rule will follow. Some crops are more sensitive to borax than others, and also the tendency to injury appears to vary on different soils. It is necessary, therefore, to repeat the warning

[9] *Veratrum viride* or *V. aloum.*

issued in connection with a previous bulletin[10] on this subject, that great care be exercised, in the application of borax, that the manure does not receive more than 1 pound for every 16 cubic feet, and that not more than 15 tons of manure so treated are applied to the acre.

In view of the possible injury from the borax treatment as a result of carelessness in applying it, or from other unforeseen conditions, it is recommended that horse manure and other farmyard manures which are to be used as fertilizer be treated with hellebore. Borax, on the other hand, is such a good larvicide that it can be used with advantage on the ground of soil-floor stables, in privies, on refuse piles, and on any accumulations of fermenting organic matter which are not to be used for fertilizing purposes.

TREATMENT WITH CALCIUM CYANAMID AND ACID PHOSPHATE.

Many experiments with mixtures of commercial fertilizers were tried to determine whether fly larvæ would be killed by any substance the addition of which would increase the fertilizing value of the manure. A mixture of calcium cyanamid and acid phosphate was found to possess considerable larvicidal action. Several experiments showed that ½ pound of calcium cyanamid plus ½ pound of acid phosphate to each bushel of manure gave an apparent larvicidal action of 98 per cent. The mixture in the form of a powder was scattered evenly over the surface and then wet down with water. The use of this mixture adds to the manure two important elements, nitrogen and phosphorus.

MAGGOT TRAP FOR DESTRUCTION OF FLY LARVÆ FROM HORSE MANURE.

The second method of handling manure is one which does not require the application of chemicals. It is based on the fact, mentioned on page 4, that the larvæ of the house fly, a few hours before they are ready to pupate, show a strong tendency to migrate. This migration takes place mostly at night, and the larvæ sometimes crawl considerable distances from the manure pile. Now it is possible by means of a very simple arrangement called a maggot trap to destroy fully 99 per cent of all maggots breeding in a given lot of manure. A successful maggot trap which the Maryland Agricultural College constructed at the college barn is shown in Figure 9. The trap was designed by R. H. Hutchison and constructed under his supervision. The manure, instead of being thrown on the ground, is heaped carefully on a slatted platform, which stands about 1 foot high. This particular platform measures 10 by 20 feet. There are six 2 by 4 pieces running lengthwise 2 feet apart. Across these are nailed 1-inch strips with ½ to 1 inch spaces between them. The wooden platform stands on a concrete floor, and a rim or wall of concrete 4 inches high surrounds the floor. The floor slopes a little toward one corner, from which a pipe leads to a small cistern near by. This pipe is plugged with a stopper of soft wood, and the concrete floor is filled with water to a depth of 1 inch in the shallowest part. Flies will lay their eggs on the manure as usual, but the maggots, when they have finished feeding and begin to migrate, crawl out of the

[10] Department Bulletin 118, U. S. Department of Agriculture, p. 25.

manure, drop into the water below, and are drowned. Each week the plug is removed from the pipe, and all the maggots are washed into the cistern. The floor is then cleaned of any solid particles by means of a long-handled stable broom or by a strong stream of water from a hose. The pipe being again plugged, the floor is again partly filled with water and the trap is ready for another week's catch. A platform of this size will hold the manure accumulating from four horses during the period of four months, or about 20 days' accumulation from 25 horses, if the heap is well built and made at least 5 feet high.

Experience with this maggot trap clearly indicates that best results can be secured if the manure is compactly heaped on the platform

FIG. 9.—A maggot trap for house-fly control. View showing the concrete basin containing water in which larvæ are drowned, and the wooden platform on which manure is heaped. (Hutchison.)

and kept thoroughly moistened. It is best to apply a small amount of water each morning after the stable cleanings have been added to the pile.

It should be borne in mind that in order to make this trap a success the platform beneath the pile must be kept comparatively free of accumulations of manure, and moisture applied regularly to drive the maggots out.

COMPACT HEAPING OF MANURE.

Another method of disposing of manure has been recommended by English writers. The manure is built up in a compact rectangular heap, the sides of which are beaten hard with shovels. The ground around the edges of the heap is made smooth and hard and

loose straw is placed in small windrows around the manure pile about 1 foot from the edge. The exclusion of the air, together with the high temperature and gases formed by fermentation, tends to make the heap unfavorable for the development of fly larvæ. Those which do happen to develop in the surface layers will migrate and pupate in the ring of straw around the heap, where they are destroyed by burning.

GARBAGE DISPOSAL AND TREATMENT OF MISCELLANEOUS BREEDING PLACES.

It is just as true under farm conditions as in cities that breeding places other than horse manure must be attended to. Garbage must be disposed of, hog and poultry manure must be cared for, and especially on dairy farms it is extremely important that every precaution be taken to prevent the contamination of milk by flies.

It is very desirable that all refuse possible, accumulated from cities and towns, be burned. Incineration has been practiced successfully by a number of towns and cities with populations of from 10,000 to 15,000 and over. In larger cities provision should be made for burning carcasses as well as garbage and other refuse. If city and town garbage is sold to hog feeders the municipal authorities should have control of the sanitary conditions about the feeding yards, as there is great danger from fly breeding in such places if not kept clean.

SEWAGE DISPOSAL IN RELATION TO THE PREVENTION OF FLY-BORNE DISEASES.

In the consideration of these measures we have not touched upon the remedies for house flies breeding in human excrement. On account of the danger of the carriage of typhoid fever, the dropping of human excrement in the open in cities or towns, either in vacant lots or in dark alleyways, should be made a misdemeanor, and the same care should be taken by the sanitary authorities to remove or cover up such depositions as is taken in the removal of the bodies of dead animals. For modern methods of sewage disposal adapted for farm use one should consult Department of Agriculture Department Bulletin No. 57. In the absence of modern methods of sewage disposal, absolutely sanitary privies are prime necessities, whether in towns or on farms. Directions for building and caring for such privies will be found in Farmers' Bulletin 463 and in Yearbook Separate 712, "Sewage Disposal on the Farm." The box privy is always a nuisance from many points of view, and is undoubtedly dangerous as a breeder of flies which may carry the germs of intestinal diseases. The dry-earth treatment of privies is unsatisfactory. No box privy should be permitted to exist unless it is thoroughly and regularly treated with some effective larvicide. Since the fecal matter in such privies is seldom used for fertilizing purposes it may well be treated liberally with borax. The powdered borax may be scattered two or three times a week over the exposed surface so as to whiten it.

WHAT COMMUNITIES CAN DO TO ELIMINATE THE HOUSE FLY.

Antifly crusades have been very numerous in recent years, and some have been noteworthy both in methods and in results. However, it will not be amiss here to emphasize the importance of concerted, organized effort on the part of whole communities, not only cities, but suburban and rural neighborhoods as well. By the most painstaking care one may prevent all fly breeding on his premises, but it will avail him little if his neighbors are not equally careful. Some sort of cooperation is necessary. One of the first and most important elements in any antifly crusade is a vigorous and continued educational campaign. It has been the experience of those who have undertaken such crusades that people generally regard the fly as a somewhat harmless nuisance and that the first work of the campaign was to bring the people to a realization of the dangers from flies and the possibility of getting rid of them. In the educational campaign every possible means of publicity can be employed, including newspapers, lectures, moving pictures, posters, handbills, cartoons, instruction in schools, etc.

The antifly crusade is a matter of public interest and should be supported by the community as a whole and engineered by the health officers. But health officers can do little toward the necessary work of inspection and elimination without funds, and therefore the support of the campaign must manifest itself in increased appropriations for public-health work. Very often it is lack of funds which prevents the health officers from taking the initiative in the antifly crusades, and there must necessarily be much agitation and education before they can profitably take up the work. Right here lies a field for civic associations, women's clubs, boards of trade, etc., to exercise their best energy, initiative, and leadership.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

November 12, 1923.

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